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28 September 2018

Online at https://mpra.ub.uni-muenchen.de/91615/
MPRA Paper No. 91615, posted 22 January 2019 10:51 UTC

Money Neutrality: An Empirical Assessment for Mexico

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September 29, 2018
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Abstract

The quantity theory of money assumes that money itself is neutral with respect to real output, both in the long and short term. Therefore, this last period should not be affected by changes in money supply. A review of the literature is carried out in order to provide a framework for the empirical analysis. To test the above proposition for Mexico, M1 is used, while GDP, duly adjusted for inflation stands for output. The period under consideration covers from the first quarter of 1993 to the first quarter of 2018. The results expose a cubic function. For the long term and with respect to M1, the price elasticity is positive with a substantial coefficient (10.03). In its squared portion, the coefficient is inelastic and negative (-0.49). Finally, the cubic coefficient is close to zero (0.01). These three coefficients bear a one period lag. Besides, a dummy variable comprising the four quarters of 1995, when the Mexican economy experienced a recession, was introduced. In the short term, the coefficient for the straight section is considerably large (38.19), being negative and elastic in its square tranche (-1.81), and almost negligible in its cubic portion (0.03). As a result of the above estimates, while there has been a considerable effect in real output as a result of increases in the money supply, particularly in the early years considered, its value has been receding at a considerable pace. These results apply in the long as well as in the short term. The only difference in this similar pattern is that such effect has been stronger during the short term. With respect to the theoretical tenets underling the subject, it should be observed that the effects of money supply in real output are mixed, depending on the periods under consideration.

Keywords: Money neutrality in Mexico; quantity theory of money.

JEL codes: E13; E17; E41; E52.

1. Introduction

The relation between money and prices is one of the oldest surviving propositions in economics. It could be traced back to the mercantilist doctrine. This relation links money to prices in a direct fashion. It points out that increases in the quantity of the former raises the price level in a one to one proportion. Known as the quantity theory of money, it conveys mainly long term equilibrium implications. In other words, money supply should have no influence in real economic variables such as output or employment in the long term. It is from this premise that money neutrality is presupposed. If this proposition holds, money would be restricted as a medium of exchange and as a standard of value.

In the first part of this paper, the literature on money and its effects on output are examined. In this respect, the neutrality of money is considered both in terms of its short term and long term nature. Afterwards, a model is proposed to evaluate empirically the effects of money in real output by means of two equations. The first equation estimates whether real GDP (Gross Domestic Product) is neutral with respect to M1 (coins; banknotes, and deposit accounts) in the long term. The second equation estimates neutrality once again with GDP, but with respect to the short term. The results are analyzed in the light of what the quantity theory scheme prescribes, while they are confronted with similar studies in the field. Finally, a set of conclusions are being presented.

2. Review of Literature

The origin of the quantity equation, which formalizes the quantity theory of money, could be traced back to Bodin in 1566. Is in his reply to Malestroict, who links French inflation to coin clipping *i.e.*, currency debasement, Bodin argues otherwise. According to this last author, inflation is the result of bullion shipments from America, which in his view has caused a general price acceleration in the two previous centuries (Graff, 2008). This perspective is also shared by Hume (1742), one of the most important proponents of the quantity theory of money in the XVIII century, where prices of commodities are always in proportion to the abundance of money.

The quantity equation assumes a dichotomy between a monetary economy and the real economy. The former is being simply juxtaposed, while not integrated. Therefore, any change in the former cannot modify the real

economic variables. As a result, an expansion or contraction of the real economy would indeed affect prices in the same proportion and direction. As part of these dichotomic assumptions, output would remain unaffected by exogenous changes in the quantity of money. This exogenous effect is most of the times identified with the central bank money supply management policy. Within the quantity equation conception, its economic paradigm assumes what it attempts to prove. In other words, once the dichotomy is presupposed, possible vagaries in the shortage or plethora of money cannot modify the level of output. This would imply the existence of an imaginary economy where production and exchange take place without money, this last one being reduced to a simple veil. Therefore, given this theory setting, it is difficult to understand why money is used in the real economy to conduct production processes, *i.e.* acquiring inputs and selling them. In consequence, the very conception of a pure economy without money would be devoided of any practical relevance.

The concept of money neutrality is at the basis of the quantity equation of money. Considering early preconceptions, it goes as far back as Hume (Patinkin, 1987). Hayek (2008) retakes it in the last century, toward the early thirties. The conditions to attain such neutrality, *i.e.* that monetary disturbances cannot distort real prices require, in turn, three premises to take place. The first is that the supply of money remains constant. The second is a full price flexibility and third, a foreknowledge of economic agents, who can anticipate correctly future price movements. It is only when these three conditions take place, that money neutrality could prevail. Further, Hayek (1990) acknowledged that in the absence of these three conditions, for practical purposes, the concept of money neutrality is untenable.

In recent times, a resurgence of monetarism took place around 1970, as United States experienced an inflation surge, further unleashed elsewhere with the rise in oil prices. Also, Keynesian policies as a government deficit spending appeared to be inefficient in combating unemployment. It was upon this scenario that monetary policy took place at the center stage. The success of the monetarist liquidity preference theory, previously produced by Friedman in 1956, got immediate popularity among economic practitioners and theorists as well. This success phenomenon was the result of it being an instrument to target inflation.

Regarding the quantity theory of money as a policy means, the United States abolished monetary targeting in the early 1980's (Graff, 2008). This tendency was also observed in México in 1988, when reserve requirements by the central bank were phased out (Khamis & Leone, 2001). In its place, open market operations were established while the interest rate becomes the means for inflation targeting. In other words, an attempt to keep inflation close to an announced target ensued. Some authors even challenge that in the Latin American region there was an adherence to monetary targeting, in so far as public announcement of targets and some kind of accountability mechanism did not occur (Mishkin & Savastano, 2000). As a result, it is not enough to use the information conveyed by the central bank to implement a monetary policy, if it lacks public transparency.

Since 1990, monetary targeting gave way to inflation targeting in an array of industrialized countries, including Canada, United Kingdom and Switzerland. This adoption encompassed many countries including Brazil and Chile in Latin America as well as transition economies like Czech Republic, Hungary and Poland. Nevertheless, the quantity theory of money continues to be a source of widespread controversy (Laidler, 1991).

2.1. Long term neutrality; short term neutrality

There is a general agreement among subscribers to money neutrality: in the long term, money supply does not affect real variables.[1] However a distinction is made regarding the short term, where money need not be neutral. Hume himself shares this point of view, as well as the New Keynesians.[2] Therefore, this persuasion concedes that money could be non-neutral in the short term.

Brunner and Meltzer (1997) make a similar distinction regarding the short and long term as far as the influence of money is concerned. For instance, they mention that for the long term: "When classical economists accepted that money could not affect income, they generally meant that money was neutral in the long-run -that real wealth or expected real income was independent of the quantity of money." Meanwhile, their view for the short term is worded as follows: "Money is neutral in the long-run but not in the short-run. Changes in money affect output first, but this effect vanishes once prices adjust fully. The long-run effect of money is on prices, but money changes output and other real variables during the adjustment from one long-run equilibrium to the next."

In a similar fashion, Milton Friedman (1956) underlines a direct relation between the stock of money and the price level. He enunciates a sort of regular pattern or constant behavior in economics:

> "25. One of the chief reproaches directed at economics as an allegedly empirical science is that it can offer so few numerical 'constants,' that it has isolated so few fundamental regularities. The field of money is the chief example one can offer in rebuttal: there is perhaps no other empirical relation in economics that has been observed to recur so uniformly under so wide a variety of circumstances as the relation between substantial changes over short periods in the stock of money and in prices; the one is invariable linked with the other and is

[1] According with Cooray, Mecagni & Offerdal (1998) "Classical theory suggests that while in the long run inflation is determined by nominal money growth, relative price adjustment reflects real factors and would not affect the increase in overall prices."

[2] According to Mankiw (1992) "Old classical economists, such as David Hume, asserted that money was neutral in the long run but not in the short run. This is exactly the position held by new Keynesians. By contrast, new classical economists claim that money is neutral even in the short run. In advocating this position, they take the classical dichotomy more seriously than did the classical economists themselves."

in the same direction; this uniformity is, I suspect, of the same order as many of the uniformities that form the basis of the physical sciences."

Hence, in the above quotation, expansions in the money stock or money supply are proportionally associated to prices and *vice versa*. Further, Friedman has been claimed that "inflation is always and everywhere a monetary phenomenon."[3] It is in this sense that monetarism alerts that any inflationary economic disturbance has its origin in monetary fluctuations. As for extending this proposition, Friedman (1956) concedes that: "The quantity theory of money is a term evocative of a general approach, rather than a label for a well-defined theory." New classical economics is persuaded about both the long and short term money neutrality.[4] This includes what they call the real business cycle theory. For instance:

> "Early studies found that monetary shocks pushed through this channel could account at best for a minor fraction of the variance of output in post-war U.S. cycles. This failure led to a second round of attempts to find a *direct* empirical role for monetary shocks, …. Barro and Mishkin attained results that eventually gave courage to the subscribers of the real business cycle theory to neglect *all* monetary and price level disturbances."[5] Emphasis in the original (CCDN).

That is to say, new classical economics and the real business cycle theory do not envisage any changes in the real economy on account of price fluctuations or monetary variables disturbances.

For his part, Patinkin (1969) acknowledges that the quantity identity is a truism, which does not need to be tested.[6] He follows Mint, who claims that prices could be established as a dependent variable:

> "Some attempts [have been made statistically] to verify quantity theory by showing that $MV+M'V'=PT$ is true. But quantity theory says that P *is the dependent variable*. So would have to show that exist consistent time lags. Have to establish *causal relationship*. Formula itself is a truism –doesn't need verification. Formula ≠ quantity theory.
>
> . . . . . .
>
> Mints prefers following statement of quantity theory: P is the dependent variable (in the long run) of the equation MV=PT. But in the short run all the variables tend to move together.[30]" Emphasis in the original (CCDN).

Here, Patinkin is referring to the identity of Fisher (1911a), whereby "M signifies the quantity of money in circulation; V, its velocity of circulation, or rate of turnover per annum." According to Patinkin, the distinction between the quantity theory and the corresponding formula is also emphasized by Friedman (1968) in his article contained in the encyclopedia *Quantity Theory II.*

Recently, Lucas (1972) reconciles the non-neutrality of money in the short term with its neutrality in the long term. This author assumes that agents use a veritable conditional distribution to build their expectations, presupposing that they are being rational. Lucas also assumes, that all exchanges are done in such a way that market clearing is assured. This would imply, as a result, that markets are efficient.[7] In the long term prices adjust entirely, in so far as a thorough monetary shock is fully perceived by economic agents.[8] Meanwhile in the short term real variables are affected, in the way established within the Phillips curve framework.[9] It should be acknowledged that Lucas underlined policy implications, regarding the short term effect of money in referring to real variables: output and employment.[10] However, market clearing has been a central issue for the avowed theory, being a matter that can be put into question.

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[3] "8. It follows from the propositions I have so far stated that *inflation is always and everywhere a monetary phenomenon* in the sense that it is and can be produced only by a more rapid increase in the quantity of money than in output." Friedman (1970). Emphasis in the original (CCDN).

[4] "Old classical economists, such as David Hume, asserted that money was neutral in the long run but not in the short run. This is exactly the position held by new Keynesians. By contrast, new classical economists claim that money is neutral even in the short run. In advocating this position, they take the classical dichotomy more seriously than did the classical economists themselves." Mankiw (1992).

[5] Sargent (1996).

[6] In Patinkin (1969) the corresponding footnote 30 says "Lecture notes from Lloyd Mints, 'Money' (Economics 330), June 28 and July 3, 1944, italics in original. It is noteworthy that this distinction between the quantity theory and the identity $MV+M'V'=PT$ is also emphasized by Friedman in his encyclopedia article: see *Quantity Theory II*, pp. 434-36." It should be added that for Patinkin and Mints money is neutral in the short term. Emphasis in the original (CCDN).

[7] "The assumption that traders use the correct conditional distribution in forming expectations, together with the assumption that all exchanges take place at the market clearing price, implies that markets in this economy are *efficient*, as this term is defined by Roll [1968]. It will also be true that price expectations are *rational* in the sense of Muth [1961]." Lucas (1972). Note: In the Lucas paper the references to Roll and Muth are indicated by numbers. For the sake of clarity, here these numbers have been substituted by the publication year, being added to the present references section. Emphasis in the original (CCDN).

[8] "If the factor disturbing the economy is exclusively monetary, then current price will adjust *proportionally* to changes in the money supply." Lucas (1972). Emphasis in the original (CCDN).

[9] "This hedging behavior results in a non-neutrality of money, or broadly speaking a Phillips curve, similar in nature to that which we observe in reality. At the same time, classical results on the long-run neutrality of money, or independence of real and nominal magnitudes, continue to hold." Lucas (1972).

[10] "This tension between two incompatible ideas -that changes in money are neutral unit changes and that they induce movements in employment and production in the same direction- has been at the center of monetary theory at least since Hume wrote" Lucas (1996).

In Hall & Taylor (1988), it is possible to find an analytical framework worth mentioning. They explain that sometimes money is taken as an exogenous variable. This treatment conveys a long term tradition in the field of macroeconomics.[11] At other times, money could be considered endogenous if a policy rule is established. In this last case, the maintenance of a constant growth rate in money supply could be interpreted as the result of a behavioral relationship. Friedman (1956) uses to call this relationship "institutional conditions." In this sense, Hall & Taylor share Friedman point of view, regarding the constant growth rate rule in money supply. That is to say, money supply increases are assumed to be endogenous.

In contrast to the money supply endogeneity above beholding, Tobin (1970) had the contemporary acumen to note that output might be causing changes in money supply. Therefore, output is the control variable but not money. As a logical result, the so called reverse causation argument was put forward. Therefore, money would confirm itself as a variable responding to output variations, leaving little scope for an endogenous monetary policy to operate efficiently.[12]

2.2. Noting possible neoclassical misperceptions

One specification of the previous-mentioned Lucas scheme (1972) refers to a specific scenario. The scenario itself has rational agents receiving inadequate information regarding market prices. In other words, these rational agents do not distinguish between real and monetary shocks. As a result, monetary shocks modify real output in the same direction.[13] This logical and coherent outcome of this specific scenario is possible when misperceptions hold. It becomes materialized in a situation whereby rational agents do not have favorable expectations about the economy, and at the same time, they lack perfect price information. Therefore, an increase in money supply would affect real economic variables *i.e.*, output. Under this scenario, an increase in money supply does not need to be translated into price rises. Considering this perspective, its implications should be considered. For example, this may imply a reverse direction on Friedman's constant. As a result, an economic recession might occur given a monetary contraction.

An alternative to what has been revised in relation with Friedman money constant is related to luxuries goods. He mentions that for this kind of articles, a real balances coefficient greater than one is expected for its income elasticity of demand.[14] If the income elasticity of demand coefficient for luxuries is bigger than one, then it should follow that the respective coefficient for normal goods is close to one. These interpretations convey necessarily the *ceteris paribus* clause, since money velocity and volume of trade are considered to remain without change. If these last two parameters do not remain constant, Fisher (1911b) claims that an increase in money supply could lead to an inflationary process.[15]

3. Methodology

A means to test the case for money neutrality is through empirical verification. That is to say, the effect of money supply in output level duly adjusted for inflation is tested. Although the result is to abide by customary time series statistical structures, its validity holds for a specific period of time. In this respect, a quantitative test for this proof has a limited validity in relative time terms. Replication for further periods would become a convenient procedure, in order to find possible results robustness to build up a consistent pattern of behavior. In order to empirically evaluate the neutrality of money, the following equation is being proposed:

$$GDP/p=f(M1_{-i}) \qquad (1)$$

where *GDP* is the gross domestic product in nominal terms; *p* is a price index; *M*1 is money represented by coins, banknotes and deposit accounts. This expression allows for lags duly specified by *i*. The purpose of this equation is to estimate the effect of money in real output. Money neutrality claims that money, which in this case is represented by *M1* has no effect whatsoever in the level of output, adjusted for inflation. Thus, at least in the long term, a coefficient close to nil is expected. In the above model, two strong assumptions are being held. First, output is constrained to gross value added. In addition, money is treated as an exogenous element.

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[11] "Treating policy variables as exogenous has long been a tradition in macroeconomics. But more recently an alternative view, that they should be treated as endogenous, is becoming more attractive. Endogenous policy is determined according to some behavioral relationship, or what is called a **policy rule**. The most frequently discussed policy rule in macroeconomics is the fixed growth rate rule for the money supply that Milton Friedman and other monetarists have advocated. A fixed growth rate rule is simply to keep the growth rate of the money supply constant. But this is a very special rule in that it involves no response of the money supply to economic events." Hall & Taylor (1988). Bold text in the original (CCDN).

[12] It is beyond the scope of this paper to tackle this question.

[13] "These rational agents are then placed in a setting in which the information conveyed to traders by market prices is inadequate to permit them to distinguish real from monetary disturbances. In this setting, monetary fluctuations lead to real output movement in the same direction." Lucas (1972).

[14] This is endorsed by Friedman, when he analyses the econometric implications of real rises in cash balances or real rises in the stock of money, as follows: "The secular rise in real income has been accompanied by a rise in real cash balances per unit of output -a decline in velocity- from which Selden concludes that the income elasticity of the demand for real balances is greater than unity—cash balances are a 'luxury' in the terminology generally adopted." Friedman (1956).

[15] "We have noted that in these cases, as in others, prices depended on the quantity of money, its velocity, and the volume of business." Fisher (1911b).

4. Data Analysis

Data collection comprises from the first quarter of 1993 (1993:1) to the first quarter of 2018 (2018:1) for the Mexican economy. GDP adjusted for inflation (*GDP/p*) is to stand as real output. The Mexican statistical office (INEGI), produces data on national accounts, including the GDP as well as the price index. Money supply, specifically M1, was obtained from *Banco de Mexico*, the Mexican central bank. This data is available on a monthly basis. As a consequence, M1 monthly frequency was modified in order to match GDP quarterly frequency by means of a simple average. The set of variables used in the estimation and their sources are reported in Annex I.

5. Results

A cointegration test for the variables involved in equation (1) is performed, before the regression estimates were made.[16] Besides, an evaluation of the Mexican economy was performed regarding the neutrality of money for the Mexican economy, by means of cointegrating equations. As a result, long and short term coefficients have been obtained, for differentiate the effect of both time spans in the dependent variable.

Table 1. Mexico. Elastictiy of output (GDP), adjusted for inflation with respect to money (M1). Time period 1993:1-2018:1

log GDP/ipi_{GDP}

Long term		*Short term*	
$\log M1_{-1}$	10.03	$\Delta \log M1_{-1}$	38.19
	(2.55)**		(1.95)*
$\log M1^2_{-1}$	-0.49	$\Delta \log M1^2_{-1}$	-1.81
	(-2.56)***		(-1.86)**
$\log M1^3_{-1}$	0.01	$\Delta \log M1^3_{-1}$	0.03
	(2.60)***		(-1.76)**
$D_{1995.1\text{-}1995.4}$	-0.04		-0.02
	(-2.53)***		(-1.99)*
c	-52.53		0.02
	(-1.97)*		(4.36)***
residual			-0.68
			(-6.94)***
R^2 adjusted	0.98		0.49
D.W.	1.71		2.14
Akaike criterion	-4.42		-4.68
n	1993:2-2018:1		1993:2-2018:1

Note: t values in parenthesis. Significance for t values: ( )***:99%; ( )**: 95%; ( )*: 90%.

5.1. Long term

The long term comprises from the first quarter of 1993 to the first quarter of 2018. In estimating the effect of money in real output, an elasticity coefficient of 10.03 is obtained for the long term in the straight stretch of the curve with a one quarter lag (Table 1). A decreasing growth is observed when M2 is squared (-0.49), while a slope with an almost negligible value appears, when M1 is raised to the third power (0.01). In these three cases, M1 conveys a one year lag. A dummy variable for the entire year of 1995 has been introduced ($D_{1995.1\text{-}1995.4}$). As a result, the effect of M1 in real GDP grows at a lessening rate. This dummy expresses a decreasing growth of GDP adjusted for inflation, with respect to the previous year quarter,[17] conveying a recession of the Mexican economy. The period under consideration comprises from the first quarter of 1993 to the fourth quarter of 2018.

5.2. Short term

The short term comprises from the third quarter of 1993 to the first quarter of 2018.[18] The first differences symbol in the third column (Δ) implies that the long-term cyclical component of money is removed from *M1* and GDP/ipi_{GDP} for the short term estimation. The cubic function yields an elasticity of 38.19 in its straight portion (*M1*), while its coefficient is negative and elastic (-1.81) in its squared section ($M1^2$), exposing an extremely low

[16] In Annex II, cointegration test for variables in equation (1) are being reported. Stationary results of residuals for the long term cointegrating equation are exposed in Annex III.

[17] This is done in order to take seasonality into consideration.

[18] Long term cointegrating equations residuals are stationary. They were tested for unit root, and their results are reported in Annex III.

coefficient (0.03) in its cubic form ($M1^3$). As in the case of long term estimates, a one period lag is comprised. Also, a dummy variable ($D_{1995.1\text{-}1995.4}$) encompassing the four quarters comprised in 1995 is being incorporated.

6. Discussion

Regarding the literature that uses the time series econometric analysis, King & Plosser (1984) decompose M1 in high powered money and deposits. The effect of deposits in real output ranges from 0.740 to 0.784, while high powered money exposes a coefficient of 0.510. For these authors money is not neutral for the time period from 1953 to 1978, on an annual basis for United States. As far as Koustas (1998) is concerned, he rejects the long term money neutrality having obtained positive values greater than 0.20, comprising from the first quarter of 1953 to the fourth quarter of 1993 regarding Canada.

In estimating the effect of money in real output, Noriega, Soria & Velázquez (2002) consider an array of countries in their analysis of money neutrality. Regarding Mexico, they examine broken trends between M2 and output from 1932 to 2000, concluding that it would be difficult to argue that money is neutral.

Further, Shelley & Wallace (2003) examine the Mexican case between 1932 and 2001, using real GDP and M2. Money neutrality is rejected for the whole period. However, considering that there is a break in the Mexican economy at the beginning of the 1980's, the authors adjust for a change in the mean growth as from 1981. This is in so far as the Mexican economy grew consecutively for the first 50 years of the period under study, and a structural change is perceived between 1981 and the next year. With this last adjustment, neutrality is not rejected in the long term. In the case of Guatemala assembling data from 1980 to 2002, and exclusively considering the long term, Wallace & Cabrera-Castellanos (2006), cannot reject the neutrality hypothesis regarding both M1 and M2 with respect to real GDP.

In the case of Gonzalez Milan & Avila Arce (2012) find an inelastic (-0.0469) long term coefficient of GDP with respect to M2 for the Mexican economy from 1980 to 2007, on a quarterly basis, rejecting the money neutrality hypothesis.

Considering the above results, the empirical evidence in the literature generally exposes a lack of money neutrality, when its effect in GDP is being estimated. There is a convergence in terms of results in different time periods and countries. The results obtained in the present paper expose a lack of money neutrality in the early period of analysis, *i.e.*, as from 1993. It should be conceded that afterwards, the expansion of M1 substantially reduces its effect in real output, becoming negligible.

7. Conclusions

The theory tenets of money neutrality were tested for the Mexican economy, comprising from 1993 to 2018 on a quarterly basis. A cubic function was obtained regarding the elasticity of real output with respect to M1 with one period lag. Besides, a dummy variable was introduced throughout 1995 to account for a local recession. The money supply effect has a substantial effect at an early period. However, such function depicts a diminishing effect throughout time. As a result, in recent periods, the effect of money supply in the Mexican output appears to have lost vigor, as hardly any effect is exposed.

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Annexes

Annex I. Data sources and list of abbreviations
Time period: 1993:1-2018:1

Nemonic	Series	Units	Frequency	Source
GDP	Gross domestic product	Millions of Mexican pesos	Quarterly	B
M1	Paper notes and coins in the hands of the public plus checking accounts	Thousands of Mexican pesos	Monthly	A
p	GDP implicit price index	Second fortnight of December 2010 =100	Quarterly	B

A: Banco de México (BANXICO). B: Instituto Nacional de Estadística y Geografía (Inegi).

Annnex II. Cointegration test
Time period: 1994:2-2017:4
Included observations: 95 after adjustments. Trend assumption: No deterministic trend
Series: GDP/ipiGDP; M1
Lags interval (in first differences): 1 to 4. Unrestricted Cointegration Rank Test (Trace)

Hypothesized number of cointegrating equations	Eigenvalue	Trace statistics	0.05 Critical Value	Probability**
None *	0.121	15.973	12.321	0.012
At most 1	0.038	3.699	4.130	0.065

Trace test indicates 1 cointegrating equation at the 0.05 level. * Denotes rejection of the hypothesis at the 0.05 level. **MacKinnon-Haug-Michelis (1999) p-values.

Annex III. Unit root test
Time period: 1994:1-2017:4
Cointegrating equation. Augmented Diceky Fuller test statistic
Test in first differences

Test critical value	Significance	Critical value§	Exogenous**
-4.227	1%	-3.501	a
-4.202	1%	-4.058	b
-4.255	1%	-2.590	c

§ Mackinnon (1996) one-sided p-values. ** a: constant; b: constant and linear trend and c: none.
Note: The null hypothesis of the existence of a unit root is rejected in all cases.